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COMPARISON OF WIND INPUT DATA FOR USE IN DETERMINATION OF MISSILE AND SPACE VEHICLE DESIGN BY STATISTICAL METHODS

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DYNAMICS ANALYSIS BRANCH
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ABSTRACT

This report presents a comparison of selected statistical wind summaries compiled from upper air observations made at Patrick AFB, Florida. A description of how this data was developed into convariance matrices is presented. Also a brief outline of how these convariance matrices can be utilized in control and trajectory studies is considered.

ACKNOWLEDGMENT

The authors of this report gratefully acknowledge the assistance of Mr. D. H. Boen in the many computations required in a report of this type. The assistance of Mr. Sieja in developing a program for calculating the convariance matrices on the Burroughs 205 Computer is also acknowledged.

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I. INTRODUCTION

The ultimate objective in designing a missile or space vehicle would be to consider the simultaneous effects of its entire flight environment. This flight environment is composed of pressure, temperature, density, and winds usually random in nature, which may be described in a statistical form. The process for describing this environment should be nonstationary rather than the standard stationary method. Stationary random processes are characterized by a set of probability functions that are invariant with a change in the time origin. When variations with time take place, the process is said to be non-stationary. Since the missile or space vehicle changes altitude as a function of time, the wind velocity for any time varies as a function of both altitude and time. Therefore, non-stationary random processes should be used to properly describe the environment.

Previous efforts have considered the effects of wind velocities separately from wind gusts or turbulence. R. E. Bieber (see reference one) proposed a method which utilized non-stationary statistical methods to determine missile structural loads. He demonstrated how the effects of wind velocity combined with turbulence or gusts might be studied simultaneously. The purpose of this report is to compare the data that Mr. Bieber utilized for a one dimensional input with the data supplied by the Aerophysics and Geophysics Branch. This branch is preparing the required cross-correlation coefficients in order to complete the two dimensional wind input data. Work is also underway preparing the means, standard deviations, and correlation coefficients for atmospheric density at various geographical locations.

II. DEVELOPMENT OF THE COVARIANCE MATRIX FROM THE CORRELATION COEFFICIENTS AND STANDARD DEVIATIONS

The Geophysics and Aerophysics Branch of the Aeroballistics Laboratory supplied the data shown in Tables 2 and 3. The procedure followed in developing the wind covariance matrix is shown in Figure 1. The standard deviation at one altitude for the North-South (meridional) wind is multiplied by the standard deviation at another altitude and this product is then multiplied by the correlation coefficient relating these different North-South winds. This computation is repeated until all the values of the North-South covariance matrix are obtained. The same procedure is then repeated for the East-West zonal winds covariance matrix.

The North-South wind covariance is then added to the East-West wind covariance to form a combined matrix. To the diagonal terms of this combined matrix is added the diagonal terms of the North-South to the East-West covariance matrix and the diagonal terms of East-West to the North-South covariance matrix. The resultant matrix represents an incomplete two dimensional matrix. This matrix was utilized as a one dimensional input by Mr. R. E. Bieber (reference one). The resulting incomplete two dimensional matrix is symmetrical, consequently only a triangular matrix need be shown. The two dimensional matrix can be completely developed by utilizing the non-diagonal parts of the North-South with East-West and the East-West with the North-South covariance matrices.

III. DESCRIPTION AND COMPARISON OF THE COVARIANCE MATRICES PRESENTED IN THIS REPORT

The statistical procedures employed to develop the covariance matrices shown in Tables 4, 5, and 6 were identical. The basic data used to develop the covariance matrices were obtained from the correlation matrices shown in Tables 1, 2, and 3. The conversion of the correlation coefficients, and the standard deviations to the covariance matrices was accomplished by utilizing the following formula. (Where X and Y are random variables)

$$\text{COVARIANCE (XY)} = \left[\begin{array}{l}\text{CORRELATION (XY)}\\ \text{COEFFICIENT}\end{array}\right]\left[\begin{array}{l}\text{STANDARD (X)}\\ \text{DEVIATION}\end{array}\right]\left[\begin{array}{l}\text{STANDARD (Y)}\\ \text{DEVIATION}\end{array}\right]$$

The main purpose of this report is to compare Mr. Bieber's covariances with those developed by the Aeroballistics Laboratory. Although the same procedures were employed in the computation of these matrices (Tables 4, 5, and 6), there exists differences in the results obtained. Tables 7, 8, 9, and 10 provieds a comparison of Bieber's data with the Aeroballistics Laboratory Data. The values shown in Table 2 were subtracted from the values shown in Table 1, to form Table 7. The values shown in Table 3 were subtracted from the values shown in Table 1 fo form Table 8. The values shown in Table 5 were subtracted from the values shown in Table 4 to form Table 9. The values shown in Table 6 were subtracted from the values shown in Table 4 to form Table 10. The differences in the covariance matrices due to the different arrangements (reference period and period of record) of the basic observation data.

The basic data used in the computations are:

(1) Table 4 employed wind data for the winter months (December, January, February) observed during the period Feb. 1950 thru Feb. 1955.

(2) Table 5 employed wind data only for the month of January as observed from January 1951 - December 1957.

(3) Table 6 employed all wind data observed during the period January 1951 thru December 1957.

Therefore, the difference between Table 4 and Tables 5 and 6 result partially from combining the observational data on a monthly, seasonal, or annual basis. It may be seen from this presentation that a seasonal (winter) covariance matrix (Table 4) results in moderate conditions relative to the monthly (January) covariance matrix. Table 5 combines the upper air wind data for a winter month (January) only and, in general, has the highest values for the covariance matrix. Due to the influence of the summer months the annual covariance has the lower covariance values. This report, therefore, illustrates the relative differences in wind data statistically grouped according to different time reference periods. The selection of which covariance matrix to use depends upon the objective of the investigation and detail on wind input data desired.

IV. UTILIZATION OF THE COVARIANCE MATRIX IN CONTROL AND TRAJECTORY STUDIES

There are several ways in which the covariance matrix might be utilized in order to obtain a statistical description of the system response to winds and/or turbulence. The approach that seems to be the most efficient consists of taking the square root of the covariance matrix.

Figure 2 shows the flow of information when the square root of the covariance matrix method is used to develop a statistical description of the system parameters. Starting with the covariance matrix, the eigenvalues and eigenvectors are determined by using conventional techniques. For every eigenvalue there is a set of eigenvectors, consequently as the size of the covariance matrix increases the amount of work to solve for the eigenvalues and eigenvectors increases. The eigenvector matrix multiplied by the square root of the eigenvalue diagonal matrix is then multiplied by the transpose of the eigenvector matrix. The resultant matrix is the square root of the covariance matrix.

The columns for the square root of the covariance matrix are then fed into the computer program as discrete profiles. The response of the system parameters to each one of these discrete profiles represents a column of the (parameter response) matrix. When all of the profiles have been run by the computer the matrix can be completely assembled. This matrix is then multiplied by its transpose. The resulting matrix represents the response to the covariance matrix for all the system parameters. The square root of the diagonal terms of this matrix represents the standard deviation from the mean for each parameter as a function of altitude. The standard deviation from the mean is multiplied by the desired number of sigmas and then added to the response to the mean value for the winds. The resultant functions of altitude represent statistical description of the control system responses.

Structural bending is a function of the output parameters of the trajectory. Therefore, it is a straightforward matter to utilize these parameter values to determine actual structural loads.

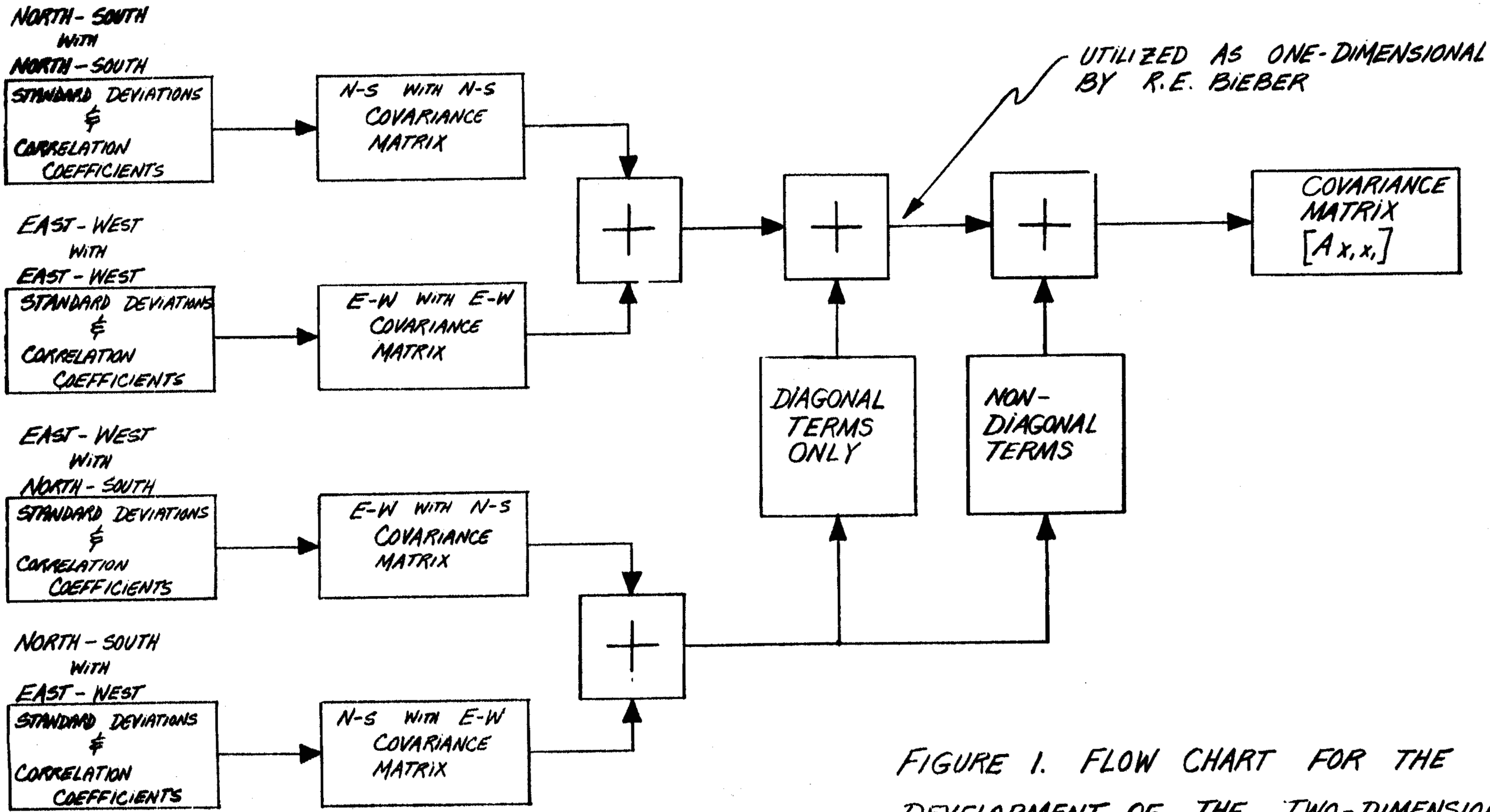

FIGURE 1. FLOW CHART FOR THE DEVELOPMENT OF THE TWO-DIMENSIONAL WIND COVARIANCE.

FIGURE 2. UTILIZATION OF THE COVARIANCE MATRIX (SQUARE ROOT METHOD)

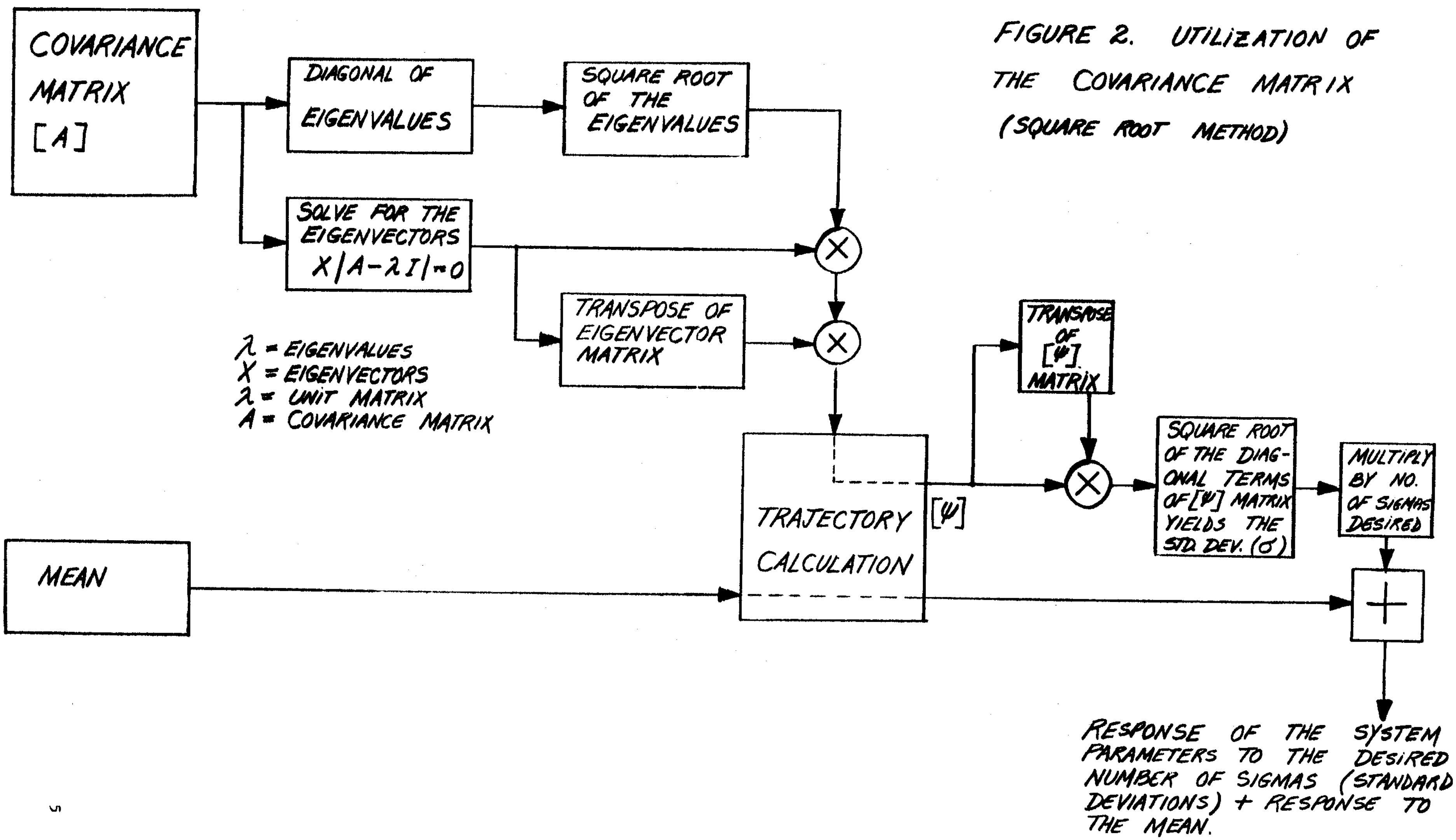

TABLE #1: INTERLEVEL AND INTRALEVEL CORRELATIONS BETWEEN WIND SPEED COMPONENTS WITH MEANS AND STANDARD DEVIATIONS OF WIND SPEED COMPONENTS BY ALTITUDE LEVELS

ZONAL AND MERIDIONAL WIND COMPONENT CORRELATIONS

PATRICK AFB, FLORIDA

WINTER MONTHS

STATION	STATION ELEVATION	STATION COORDINATES	PERIOD OF OBSERVATION	DATA SOURCE	PREPARED BY
Patrick AFB, Florida REFERENCE PERIOD Winter Months (Dec., Jan., Feb.)	7 meters MSL	28 deg 14 min N, 80 deg 36 min W	Feb 1950 - Feb 1955	Arnold Courts Data taken from R. E. Dieber's Report LMSD #3703	Army Ballistics Missile Agency Aeroballistics Laboratory Redstone Arsenal, Alabama 16 May 1960

No. of Obs.	Altitude (MSL) km	Zonal Mean m/s	SD m/s	Altitude (MSL) km: sfc	2	4	6	8	10	12	14	16	18	20	22	24	26
			Meridional Mean m/s	0.72	-0.97	-0.82	-0.61	-0.30	-0.05	0.10	0.10	0.00	0.00	0.05	0.20	0.36	0.41
			SD m/s	4.13	6.68	7.87	10.28	12.70	15.51	16.68	13.92	10.86	7.57	5.02	3.82	4.81	5.22
1468	sfc	0.15	3.65	-0.133	0.511	0.370	0.291	0.231	0.183	0.101	0.103	0.120	0.074	0.048	0.025	0.022	-0.093
1453	2	5.25	7.15	0.565	0.000	0.685	0.554	0.465	0.359	0.271	0.223	0.251	0.252	0.127	0.076	0.063	0.025
1435	4	11.89	8.54	0.511	0.768	-0.113	0.785	0.677	0.578	0.493	0.437	0.461	0.437	0.288	0.140	0.017	0.155
1409	6	18.42	10.82	0.431	0.669	0.826	0.206	0.803	0.693	0.629	0.570	0.561	0.551	0.285	0.152	-0.037	0.154
1365	8	25.27	13.49	0.373	0.615	0.760	0.845	0.236	0.843	0.717	0.657	0.631	0.547	0.316	0.074	-0.068	0.209
1315	10	32.48	16.49	0.350	0.544	0.669	0.749	0.835	0.333	0.788	0.703	0.611	0.540	0.307	0.187	-0.103	0.211
1215	12	38.35	17.97	0.258	0.448	0.524	0.594	0.694	0.772	0.304	0.708	0.682	0.558	0.274	0.116	0.000	0.113
978	14	37.32	16.94	0.238	0.425	0.529	0.560	0.626	0.674	0.740	0.271	0.769	0.648	0.283	0.121	0.000	0.137
639	16	28.41	13.76	0.218	0.410	0.489	0.515	0.594	0.595	0.646	0.706	0.228	0.688	0.368	0.188	-0.025	-0.010
412	18	17.29	13.19	0.010	0.215	0.314	0.331	0.432	0.424	0.460	0.495	0.601	0.144	0.372	0.239	0.000	0.052
306	20	6.17	10.90	0.032	0.068	0.160	0.163	0.205	0.187	0.191	0.214	0.400	0.459	0.163	0.289	0.017	0.150
251	22	3.75	11.16	0.000	0.017	0.095	0.127	0.092	0.191	0.163	0.098	0.260	0.210	0.448	0.055	0.193	0.068
203	24	5.19	12.00	-0.028	0.185	0.201	0.176	0.189	0.228	0.145	0.145	0.224	0.279	0.439	0.620	0.187	0.285
131	26	7.87	12.71	0.076	0.203	0.234	0.237	0.224	0.206	0.199	0.118	0.224	0.281	0.430	0.585	0.721	0.048

NOTE: Zonal Mean, Positive for Wind Component from West; Meridional Mean, Positive for Wind Component from South

Underlined Values Indicate Intralevel Correlations

TABLE 2:

INTERLEVEL AND INTRALEVEL CORRELATIONS BETWEEN WIND SPEED COMPONENTS WITH MEANS AND STANDARD DEVIATIONS OF WIND SPEED COMPONENTS BY ALTITUDE LEVELS

ZONAL AND MERIDIONAL WIND COMPONENT CORRELATIONS

PATRICK AFB, FLORIDA
CAPE CANAVERAL, FLORIDA

JANUARY

STATION	STATION ELEVATION	STATION COORDINATES	PERIOD OF OBSERVATION	DATA SOURCE	PREPARED BY
Patrick AFB, Florida Cape Canaveral, Florida REFERENCE PERIOD January	Patrick AFB 7 meters MSL Cape Canaveral 5 meters MSL	Patrick AFB 28 deg 14 min N, 80 deg 36 min W Cape Canaveral 28 deg 29 min N, 80 deg 33 min W	Patrick AFB January 1951-17 November 1956 Cape Canaveral 18 November 1956-December 1957	National Weather Records Center U. S. Weather Bureau Asheville, North Carolina	Army Ballistic Missile Agency Aeroballistics Laboratory Aerophysics and Geophysics Branch Redstone Arsenal, Alabama 23 February 1960

No. of Obs.	Altitude (MSL) km	Zonal Mean m/s	SD m/s	sfc	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
			Meridional Mean m/s	-0.66	0.54	-0.17	0.10	-0.02	-0.25	-0.56	-0.63	-1.12	-1.08	-1.36	-1.17	-1.62	-1.35	-1.24	-1.39	-0.79	-1.08	-0.57	-0.26	-0.28	0.24	0.50	0.60	0.93	0.66	0.96	1.18	1.83	2.54	3.84	3.10	4.01
			SD m/s	3.90	6.61	7.10	7.63	8.40	9.46	10.55	11.43	12.65	14.29	15.11	15.37	15.27	13.22	11.64	10.17	9.09	8.38	6.72	4.97	4.06	3.85	3.62	3.85	4.29	4.28	5.18	5.87	6.84	6.70	6.40	7.48	8.13
419	sfc	0.76	3.95	-.152	.609	.500	.441	.363	.291	.260	.266	.227	.168	.116	.034	-.007	.046	-.010	-.001	-.093	-.119	-.093	-.017	-.039	-.117	-.095	.030	-.008	.080	.013	-.003	.109	.148	.138	.100	.175
406	1	2.14	7.23	.628	-.117	.811	.692	.561	.467	.411	.357	.318	.205	.118	.081	.013	.072	-.004	.034	.065	.096	-.015	.024	.081	-.063	-.083	.135	.011	.188	.148	.078	.203	.288	.360	.178	.207
410	2	5.46	7.45	.572	.842	-.069	.846	.740	.682	.612	.528	.511	.417	.335	.222	.211	.272	.178	.201	.208	.271	.164	.194	.201	.167	.050	.232	.028	.199	.266	.133	.242	.332	.377	.237	.295
413	3	8.64	7.99	.549	.758	.879	-.009	.863	.779	.721	.638	.619	.539	.454	.349	.334	.375	.274	.311	.248	.311	.239	.253	.183	.171	.058	.186	.047	.239	.247	.130	.236	.283	.369	.296	.335
413	4	12.00	8.88	.531	.683	.796	.915	.034	.872	.807	.734	.712	.633	.561	.455	.438	.487	.397	.399	.393	.378	.319	.335	.283	.279	.090	.213	.037	.178	.277	.199	.280	.308	.384	.411	.487
413	5	15.28	9.85	.526	.681	.747	.844	.916	.106	.879	.782	.780	.726	.616	.528	.510	.545	.463	.464	.458	.463	.341	.325	.298	.299	.056	.181	.052	.169	.279	.066	.172	.287	.381	.400	.423
411	6	18.05	11.36	.484	.570	.696	.798	.866	.923	.182	.856	.845	.777	.671	.629	.564	.608	.817	.516	.469	.501	.388	.421	.291	.313	.123	.190	.105	.234	.267	.096	.174	.230	.344	.538	.511
409	7	21.05	12.19	.432	.496	.618	.724	.817	.863	.908	.210	.881	.814	.720	.697	.613	.646	.568	.533	.463	.489	.360	.372	.256	.172	.043	.100	.073	.191	.201	.077	.144	.135	.192	.341	.397
407	8	24.22	13.66	.391	.482	.576	.685	.761	.808	.855	.911	.166	.889	.786	.735	.639	.663	.612	.564	.490	.509	.366	.370	.189	.271	.081	.121	.067	.176	.254	.122	.187	.111	.252	.372	.400
403	9	26.78	19.13	.412	.482	.591	.666	.731	.777	.815	.868	.925	.322	.874	.815	.730	.719	.678	.633	.507	.566	.415	.448	.286	.283	.111	.086	.084	.218	.218	.133	.207	.156	.317	.368	.368
397	10	30.07	16.80	.372	.416	.545	.630	.694	.734	.766	.815	.882	.925	.341	.859	.766	.726	.670	.594	.497	.527	.422	.429	.276	.267	.144	.028	.101	.182	.214	.125	.079	-.042	.034	.080	.166
389	11	32.82	17.86	.371	.367	.507	.603	.658	.689	.709	.760	.826	.859	.890	.381	.816	.776	.714	.618	.521	.568	.403	.448	.239	.172	.093	.091	.107	.163	.134	.025	.036	-.048	.026	.291	.328
380	12	34.50	17.79	.332	.346	.488	.884	.648	.677	.697	.736	.793	.813	.839	.913	.360	.867	.749	.670	.604	.596	.477	.456	.251	.206	.143	.070	.148	.101	.066	-.019	-.048	-.165	-.116	.082	.059
359	13	34.45	16.54	.309	.358	.484	.864	.619	.643	.664	.719	.763	.782	.789	.823	.876	.358	.817	.736	.659	.658	.424	.467	.303	.226	.134	.150	.143	.176	.115	.028	.028	-.058	-.109	.165	.220
332	14	33.51	15.29	.292	.330	.454	.540	.600	.624	.661	.702	.742	.759	.764	.772	.814	.862	.392	.775	.709	.673	.531	.497	.307	.300	.183	.152	.128	.129	.089	.008	-.040	-.142	-.178	.143	.144
302	15	30.56	13.21	.241	.237	.364	.483	.528	.520	.543	.581	.602	.612	.636	.651	.739	.746	.791	.296	.779	.755	.575	.562	.370	.340	.276	.235	.226	.339	.240	.204	.308	.348	.447	.204	.088
256	16	25.67	11.22	.199	.211	.311	.429	.476	.480	.480	.526	.530	.550	.540	.566	.649	.671	.692	.716	.366	.841	.670	.585	.393	.420	.311	.270	.213	.186	.120	.144	.177	.274	.391	.050	.197
227	17	20.82	10.17	.090	.203	.318	.414	.429	.405	.423	.457	.462	.457	.457	.474	.511	.516	.566	.647	.745	.334	.706	.631	.510	.399	.238	.189	.152	.272	.226	.169	.296	.306	.462	.091	-.064
209	18	14.30	8.86	-.103	-.015	.138	.238	.241	.222	.214	.276	.271	.287	.276	.290	.334	.348	.378	.409	.539	.656	.167	.683	.448	.466	.360	.202	.243	.285	.165	.162	.189	.236	.177	.153	-.048
194	19	10.25	8.56	-.052	-.026	.086	.160	.173	.165	.153	.212	.221	.197	.233	.241	.235	.244	.347	.359	.444	.464	.493	.173	.561	.458	.327	.235	.213	.334	.288	.298	.482	.488	.381	.288	.167
182	20	6.63	7.77	-.091	-.103	-.051	.053	.054	.046	.046	.061	.082	.105	.141	.147	.170	.117	.275	.263	.465	.437	.455	.626	.207	.595	.373	.249	.191	.330	.299	.258	.362	.371	.420	.362	.322
172	21	4.07	8.36	-.140	-.142	-.128	-.078	.010	-.045	-.084	.003	-.023	-.020	-.001	.027	.078	.078	.167	.167	-.297	.372	.368	.503	.631	.113	.511	.432	.324	.371	.347	.211	.171	.273	.397	.400	.288
162	22	3.23	8.77	-.107	-.141	-.142	-.128	-.063	-.012	-.060	.007	-.047	-.035	-.018	-.041	.000	-.013	.073	.099	.241	.292	.316	.381	.598	.624	.073	.571	.519	.384	.195	.176	.090	.185	.152	.138	-.096
150	23	2.79	8.26	-.216	-.242	-.209	-.246	-.135	-.149	-.195	-.098	-.174	-.165	-.105	-.135	-.104	-.070	-.009	.063	.167	.176	.256	.211	.514	.529	.786	.305	.691	.474	.402	.415	.329	.302	.338	.405	.010
138	24	3.53	8.45	-.195	-.176	-.134	-.155	-.046	-.076	-.132	-.041	-.074	-.096	-.066	-.115	-.099	-.097	-.048	.060	.126	.142	.287	.218	.462	.576	.696	.815	.269	.693	.449	.436	.399	.356	.351	.382	.041
125	25	4.94	8.88	-.182	-.200	-.113	-.153	-.131	-.077	-.158	-.076	-.057	-.065	-.080	-.114	-.120	-.149	-.036	.075	.101	.104	.311	.284	.512	.464	.656	.636	.822	.241	.730	.890	.606	.543	.636	.609	.436
112	26	5.80	9.07	-.189	-.193	-.115	-.130	-.081	-.052	-.082	.015	-.006	-.021	-.044	-.063	-.053	-.090	.058	.088	.084	.129	.295	.227	.415	.462	.562	.639	.786	.878	.261	.771	.706	.652	.671	.551	.572
89	27	5.92	9.12	-.237	-.244	-.081	-.120	-.083	-.039	-.051	.038	.014	-.001	-.013	-.065	-.091	-.138	-.022	.036	.047	.049	.238	.300	.303	.340	.412	.417	.619	.738	.832	.186	.867	.779	.726	.626	.645
71	28	5.54	10.52	-.231	-.167	-.054	-.097	-.121	-.039	-.041	.015	.015	-.001	.041	-.063	-.066	-.117	-.004	.031	-.020	.026	.209	.340	.243	.196	.364	.331	.579	.719	.783	.936	.217	.886	.826	.723	.660
57	29	7.07	11.41	-.090	.054	-.013	-.086	-.115	-.054	-.097	-.086	-.153	-.068	-.021	-.117	-.180	-.217	-.195	-.152	.029	.159	.210	.182	.295	.425	.418	.483	.562	.608	.632	.708	.749	.199	.870	.828	.742
44	30	9.63	11.65	-.069	.094	.026	-.056	-.118	-.012	-.011	-.051	-.088	-.001	.084	-.031	-.130	-.122	-.129	-.103	-.079	.032	.195	.114	.137	.277	.300	.321	.486	.572	.531	.714	.741	.916	.109	.921	.894
30	31	11.85	13.54	.106	.071	.112	.047	-.011	.109	.110	.071	.077	.117	.162	.074	-.036	-.008	-.068	-.031	-.065	-.004	.085	-.029	.036	.185	.166	.154	.341	.495	.465	.759	.757	.827	.957	.154	.925
24	32	13.21	13.26	-.014	.098	-.030	-.048	-.149	.022	.040	-.050	-.068	-.042	.054	-.068	-.013	.036	-.048	.056	-.095	-.019	.080	.003	-.122	.001	.038	-.064	.082	.444	.386	.681	.775	.780	.927	.966	.289

NOTE: Zonal Mean, Positive for Wind Component from West; Meridional Mean, Positive for Wind Component from South

Underlined Values Indicate Intralevel Correlations

TABLE 3:

INTERLEVEL AND INTRALEVEL CORRELATIONS BETWEEN WIND SPEED COMPONENTS WITH MEANS AND STANDARD DEVIATIONS OF WIND SPEED COMPONENTS BY ALTITUDE LEVELS

ZONAL AND MERIDIONAL WIND COMPONENT CORRELATIONS

STATION	STATION ELEVATION	STATION COORDINATES	PERIOD OF OBSERVATION	DATA SOURCE	PREPARED BY	
Patrick AFB, Florida Cape Canaveral, Florida REFERENCE PERIOD Annual	Patrick AFB 7 meters MSL Cape Canaveral 5 meters MSL	Patrick AFB 28 deg 14 min N, 80 deg 36 min W Cape Canaveral 28 deg 29 min N, 80 deg 33 min W	Patrick AFB January 1951-17 November 1956 Cape Canaveral 18 November 1956-December 1957	National Weather Records Center U. S. Weather Bureau Asheville, North Carolina	Army Ballistic Missile Agency Aeroballistics Laboratory Aerophysics and Geophysics Branch Redstone Arsenal, Alabama 7 March 1960	PATRICK AFB, FLORIDA CAPE CANAVERAL, FLORIDA ANNUAL

No. of Obs.	Altitude (MSL) km	Zonal Mean m/s	SD m/s	sfc	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
	Meridional Mean m/s			-0.09	1.06	0.68	0.51	0.36	0.13	-0.08	-0.27	-0.48	-0.57	-0.78	-1.08	-1.50	-1.82	-2.01	-1.68	-1.36	-0.93	-0.61	-0.38	-0.11	0.07	0.10	0.19	0.23	0.18	0.15	0.18	0.24	0.26	0.48	0.70	1.34
	SD m/s			3.72	5.31	5.30	5.71	6.21	6.85	7.62	8.48	9.40	10.53	11.99	13.22	13.47	12.78	11.28	9.24	7.88	6.72	5.47	4.52	3.94	3.85	3.85	3.73	3.62	3.68	3.79	4.24	4.69	4.55	4.90	5.63	5.87
4981	sfc	-0.84	3.71	-.017	.654	.453	.360	.284	.225	.182	.143	.108	.057	.022	-.011	-.046	-.067	-.065	-.060	-.041	-.060	-.011	-.017	-.034	-.040	-.060	-.047	.002	.036	.028	.029	.034	.011	.039	.027	.005
4849	1	0.19	6.37	.690	.047	.761	.608	.511	.427	.372	.307	.255	.180	.127	.082	.040	.026	.013	.033	.063	.064	.060	.030	.036	-.011	-.051	-.031	.010	.051	.086	.002	.068	.028	.079	.080	.031
4875	2	2.24	6.81	.616	.830	.093	.805	.682	.593	.541	.479	.436	.361	.313	.256	.220	.194	.184	.188	.200	.216	.179	.103	.066	.050	-.002	.007	.014	.048	.079	.083	.140	.073	.042	.105	.149
4880	3	4.25	7.72	.555	.706	.881	.102	.831	.728	.669	.595	.548	.487	.435	.380	.334	.303	.292	.293	.303	.315	.269	.190	.128	.087	.034	.055	.034	.064	.086	.076	.158	.106	.073	.129	.232
4884	4	6.07	8.78	.504	.617	.791	.913	.081	.850	.764	.692	.637	.570	.523	.465	.421	.390	.372	.358	.388	.383	.332	.234	.160	.108	.049	.070	.054	.080	.116	.106	.188	.126	.089	.146	.276
4876	5	7.87	10.16	.482	.542	.725	.849	.931	.101	.860	.775	.720	.654	.593	.537	.494	.467	.439	.425	.443	.424	.358	.249	.168	.116	.067	.071	.055	.083	.107	.069	.180	.104	.092	.183	.283
4869	6	9.60	11.71	.408	.484	.678	.808	.888	.944	.129	.864	.793	.725	.662	.610	.560	.539	.516	.484	.484	.457	.384	.288	.168	.123	.089	.076	.047	.091	.094	.065	.172	.111	.099	.183	.285
4843	7	11.40	13.21	.372	.429	.631	.764	.850	.908	.951	.128	.872	.797	.740	.686	.636	.601	.578	.537	.526	.493	.401	.294	.169	.131	.108	.082	.039	.085	.088	.089	.171	.100	.048	.149	.251
4819	8	13.37	14.77	.334	.380	.583	.729	.817	.877	.919	.956	.129	.881	.817	.754	.695	.656	.629	.582	.552	.506	.412	.284	.181	.134	.109	.089	.046	.080	.087	.086	.156	.087	.108	.176	.198
4783	9	15.26	16.77	.309	.350	.550	.693	.783	.847	.887	.924	.958	.166	.896	.821	.763	.717	.682	.622	.573	.528	.434	.309	.199	.137	.099	.074	.038	.083	.097	.089	.160	.101	.107	.179	.161
4739	10	17.34	18.83	.288	.309	.513	.662	.752	.814	.857	.897	.932	.961	.175	.883	.820	.756	.713	.631	.576	.526	.439	.313	.189	.132	.106	.091	.048	.078	.083	.096	.188	.100	.128	.144	.143
4681	11	19.49	20.60	.253	.265	.478	.630	.722	.786	.832	.872	.906	.934	.957	.161	.891	.810	.749	.655	.587	.532	.448	.303	.183	.125	.103	.082	.030	.062	.089	.083	.148	.102	.111	.168	.179
4590	12	21.08	21.67	.224	.242	.455	.606	.694	.759	.809	.851	.885	.906	.927	.938	.176	.877	.791	.689	.628	.561	.464	.314	.183	.123	.097	.088	.058	.066	.068	.091	.140	.116	.122	.190	.183
4426	13	21.32	21.75	.206	.229	.434	.584	.680	.743	.792	.834	.864	.879	.897	.923	.949	.203	.851	.740	.666	.581	.478	.349	.208	.134	.110	.105	.078	.091	.088	.106	.163	.132	.120	.170	.167
4206	14	19.71	20.56	.197	.220	.426	.579	.671	.734	.781	.819	.846	.859	.870	.889	.913	.945	.211	.803	.704	.623	.515	.375	.230	.144	.116	.110	.097	.088	.075	.114	.174	.177	.168	.241	.206
3870	15	16.72	18.46	.195	.208	.411	.571	.665	.727	.773	.806	.831	.835	.843	.859	.882	.907	.934	.196	.792	.675	.566	.428	.271	.162	.141	.132	.108	.107	.098	.124	.203	.201	.213	.225	.197
3499	16	12.89	16.14	.189	.202	.407	.556	.645	.706	.745	.779	.803	.802	.807	.821	.842	.867	.887	.919	.157	.777	.630	.491	.324	.194	.150	.137	.116	.086	.092	.119	.205	.202	.225	.241	.237
3219	17	8.84	14.39	.183	.195	.389	.531	.619	.678	.711	.744	.765	.759	.766	.778	.788	.810	.832	.864	.905	.091	.719	.518	.352	.228	.155	.152	.099	.088	.099	.107	.199	.212	.222	.270	.217
2996	18	4.53	12.62	.160	.169	.356	.491	.576	.634	.663	.702	.720	.718	.722	.734	.739	.759	.789	.819	.856	.896	.041	.623	.367	.251	.184	.171	.149	.133	.118	.142	.180	.213	.151	.211	.156
2801	19	0.68	11.11	.129	.122	.303	.437	.519	.580	.614	.649	.668	.668	.666	.684	.687	.710	.746	.776	.811	.824	.869	.028	.516	.306	.251	.216	.221	.201	.166	.161	.211	.212	.218	.249	.219
2672	20	-2.45	9.97	.110	.073	.249	.375	.454	.513	.555	.587	.613	.618	.623	.633	.642	.665	.700	.726	.771	.782	.802	.864	-.010	.480	.280	.254	.225	.194	.173	.126	.184	.152	.177	.210	.198
2548	21	-4.15	9.79	.105	.073	.236	.350	.433	.490	.536	.579	.598	.604	.611	.629	.636	.656	.681	.699	.736	.754	.769	.807	.865	-.049	.558	.381	.274	.240	.211	.148	.182	.136	.187	.179	.240
2397	22	-5.26	9.79	.108	.065	.221	.328	.409	.481	.520	.568	.577	.588	.596	.605	.615	.633	.659	.681	.716	.721	.731	.770	.815	.887	-.021	.594	.377	.307	.229	.208	.172	.168	.188	.139	.159
2260	23	-5.77	10.33	.099	.045	.205	.318	.406	.464	.509	.556	.567	.568	.583	.597	.608	.633	.646	.664	.695	.700	.717	.749	.793	.843	.906	.015	.591	.360	.248	.229	.180	.161	.219	.189	.119
2096	24	-6.07	11.04	.116	.068	.221	.332	.421	.485	.532	.570	.585	.584	.588	.597	.611	.631	.646	.670	.694	.702	.721	.747	.787	.823	.867	.916	.032	.626	.369	.269	.231	.207	.244	.231	.244
1868	25	-6.05	12.11	.107	.053	.208	.320	.410	.486	.538	.581	.596	.599	.609	.610	.626	.636	.650	.681	.708	.709	.720	.757	.787	.809	.859	.878	.927	.083	.603	.367	.283	.269	.274	.211	.261
1664	26	-5.78	13.16	.129	.067	.219	.339	.434	.502	.557	.601	.614	.619	.622	.635	.649	.659	.681	.705	.721	.723	.736	.753	.777	.800	.841	.858	.898	.947	.019	.619	.426	.308	.328	.226	.309
1398	27	-5.61	14.19	.133	.082	.226	.342	.428	.501	.556	.597	.606	.614	.620	.629	.646	.652	.676	.709	.727	.728	.736	.765	.767	.794	.830	.838	.885	.923	.958	.100	.684	.446	.375	.307	.318
1153	28	-5.57	15.40	.155	.080	.227	.350	.441	.515	.571	.616	.633	.647	.650	.650	.660	.671	.694	.733	.742	.747	.756	.775	.776	.791	.833	.840	.881	.919	.940	.963	.116	.719	.518	.369	.342
872	29	-5.52	16.81	.156	.083	.235	.344	.428	.508	.578	.626	.649	.649	.656	.663	.678	.696	.719	.741	.755	.775	.772	.787	.772	.794	.833	.834	.872	.906	.919	.937	.968	.188	.676	.502	.449
620	30	-5.66	18.73	.188	.076	.251	.372	.454	.549	.597	.649	.671	.666	.686	.687	.700	.72[illegible]	.737	.757	.767	.778	.776	.795	.787	.795	.839	.831	.866	.900	.907	.926	.980	.977	.135	.764	.512
397	31	-5.11	21.03	.143	.052	.237	.350	.448	.538	.586	.645	.678	.678	.687	.684	.708	.717	.745	.764	.775	.769	.742	.777	.763	.800	.825	.818	.839	.874	.899	.915	.932	.948	.967	.168	.772
350	32	-5.26	23.10	.131	.105	.315	.375	.485	.571	.611	.640	.687	.687	.692	.679	.720	.732	.750	.786	.813	.781	.759	.804	.787	.797	.838	.806	.824	.873	.898	.914	.921	.930	.952	.972	.174

NOTE: Zonal Mean, Positive for Wind Component from West; Meridional Mean, Positive for Wind Component from South.

Underlined Values Indicate Intralevel Correlations

TABLE #4: COVARIANCE OF RESULTANT WIND VELOCITY AT INDICATED ALTITUDES AT PATRICK AFB FOR THE WINTER MONTHS (meters/sec)^2

COVARIANCE MATRIX

PATRICK AFB, FLORIDA

WINTER MONTHS

STATION	STATION ELEVATION	STATION COORDINATES	PERIOD OF OBSERVATION	DATA SOURCE	PREPARED BY
Patrick AFB, Florida REFERENCE PERIOD Winter Months (Dec., Jan., Feb.)	7 meters MSL	28 deg 14 min N, 80 deg 36 min W	Feb 1950 - Feb 1955	R. E. Bieber's Report LMSD 49703	Army Ballistics Missile Agency Aeroballistics Laboratory Redstone Arsenal, Alabama 16 May 1960

Alt. (MSL) km \ Alt. (MSL) km	sfc	2	4	6	8	10	12	14	16	18	20	22	24	26
sfc	26.43	28.92	28.04	29.46	30.59	32.88	23.94	11.10	9.59	7.15	2.28	0.40	0.79	1.83
2		95.85	83.09	89.96	98.97	101.52	87.91	72.32	57.71	33.08	9.58	3.30	17.93	19.38
4			150.28	140.14	155.59	165.13	145.45	124.65	97.07	61.54	26.35	13.30	21.57	31.84
6				268.75	228.63	244.58	243.36	184.41	139.56	90.28	34.01	21.34	21.08	40.93
8					424.57	352.52	320.77	259.67	197.69	129.71	50.42	17.48	26.49	52.37
10						683.25	433.45	340.62	236.10	155.91	57.65	46.32	37.49	60.38
12							783.90	407.03	283.80	179.81	60.49	40.15	31.32	55.39
14								608.63	281.27	179.17	59.41	25.01	29.53	35.42
16									376.23	165.92	80.21	47.80	35.73	38.67
18										260.21	80.28	37.89	44.24	49.25
20											162.06	60.14	57.94	63.62
22												143.89	79.92	77.67
24													188.98	117.37
26														195.37
Alt. (MSL) km	sfc	2	4	6	8	10	12	14	16	18	20	22	24	26

TABLE #5: COVARIANCE OF RESULTANT WIND VELOCITY AT INDICATED ALTITUDES AT PATRICK AFB FOR THE MONTH OF JANUARY (meters/sec)^2

STATION	STATION ELEVATION	STATION COORDINATES	PERIOD OF OBSERVATION	DATA SOURCE	PREPARED BY	COVARIANCE MATRIX
Patrick AFB, Florida REFERENCE PERIOD January	7 meters MSL	28 deg 14 min N, 80 deg 36 min W	Jan 1951 - Dec 1957	National Weather Records Center U. S. Weather Bureau Asheville, North Carolina	Army Ballistics Missile Agency Aeroballistics Laboratory Redstone Arsenal, Alabama 16 May 1960	PATRICK AFB, FLORIDA JANUARY

Alt. (MSL) km \ Alt. (MSL) km	sfc	2	4	6	8	10	12	14	16	18	20	22	24	26
sfc	23.60	28.97	28.63	30.21	30.16	29.02	20.58	15.39	6.05	5.68	3.13	4.67	5.85	5.82
2		98.61	96.79	104.74	104.51	104.15	87.55	66.42	39.42	16.93	2.84	7.99	7.58	2.01
4			149.41	158.87	167.98	174.74	158.07	120.28	77.43	36.97	13.38	2.17	2.12	5.53
6				283.98	245.45	253.15	231.72	178.30	106.16	49.05	16.52	1.28	7.92	6.14
8					403.99	382.64	316.14	248.09	137.57	63.91	18.41	1.92	4.91	15.90
10						683.68	427.49	314.09	170.05	83.93	35.34	5.22	2.82	10.04
12							745.25	354.54	213.38	101.59	39.10	7.90	5.38	3.33
14								508.81	193.73	92.74	47.18	17.50	0.19	13.41
16									283.17	94.51	55.04	33.95	20.25	14.20
18										143.54	43.55	33.31	28.49	29.45
20											89.92	46.23	33.66	35.53
22												94.65	59.64	48.36
24													109.31	70.22
26														133.62
Alt. (MSL) km	sfc	2	4	6	8	10	12	14	16	18	20	22	24	26

TABLE #6: COVARIANCE OF RESULTANT WIND VELOCITY AT INDICATED ALTITUDES AT PATRICK AFB FOR THE ANNUAL (meters/sec)^2						COVARIANCE MATRIX
STATION Patrick AFB, Florida REFERENCE PERIOD Annual	STATION ELEVATION 7 meters MSL	STATION COORDINATES 28 deg 14 min N, 80 deg 36 min W	PERIOD OF OBSERVATION Jan 1951 - Dec 1957	DATA SOURCE National Weather Records Center U. S. Weather Bureau Asheville, North Carolina	PREPARED BY Army Ballistics Missile Agency Aeroballistics Laboratory Redstone Arsenal, Alabama 16 May 1960	PATRICK AFB, FLORIDA ANNUAL

Alt. (MSL) km \ Alt. (MSL) km	sfc	2	4	6	8	10	12	14	16	18	20	22	24	26
sfc	27.13	24.49	22.98	22.88	22.08	20.89	15.70	12.30	10.11	7.27	3.57	3.06	4.78	6.69
2		81.18	69.74	78.91	80.36	85.67	82.56	70.68	53.09	38.78	18.20	14.69	16.88	21.31
4			124.49	127.45	143.13	163.27	167.26	147.18	110.39	75.10	43.66	36.33	42.02	52.88
6				218.21	215.75	249.45	262.77	232.38	169.87	113.98	69.84	62.22	70.07	88.58
8					342.33	351.29	371.26	323.60	232.31	155.39	96.97	87.28	96.95	122.44
10						577.35	510.69	433.25	299.68	200.36	125.89	114.76	124.32	157.90
12							753.78	526.96	361.15	236.29	148.42	138.50	148.85	188.40
14								647.82	356.92	236.49	153.71	137.68	150.89	187.46
16									362.53	201.51	134.13	117.69	126.97	158.89
18										194.85	108.82	94.19	103.40	124.62
20											114.14	83.80	89.83	104.53
22												109.08	98.96	111.69
24													137.54	135.53
26														189.45
Alt. (MSL) km	sfc	2	4	6	8	10	12	14	16	18	20	22	24	26

TABLE #7: COMPARISON OF TABLE # 1 WITH TABLE #2 *

STATION	STATION ELEVATION	STATION COORDINATES	* The values shown in Table 2 were subtracted from the values shown in Table 1		PREPARED BY	
Patrick AFB, Florida	7 meters MSL	28 deg 14 min N, 80 deg 36 min W			Army Ballistics Missile Agency Aeroballistics Laboratory Redstone Arsenal, Alabama 16 May 1960	PATRICK AFB, FLORIDA

Altitude (MSL) km	Zonal Mean m/s	SD m/s	sfc	2	4	6	8	10	12	14	16	18	20	22	24	26
Meridional Mean m/s			1.381	-0.808	-0.804	-0.058	0.811	1.309	1.723	1.343	0.790	0.570	0.331	-0.294	-0.570	-0.548
SD m/s			0.234	-0.413	-0.524	-0.264	0.055	0.406	1.420	2.280	1.777	0.853	0.970	0.205	0.329	0.045
sfc	-0.606	0.105	0.019	0.011	0.007	0.031	0.004	0.067	0.108	0.113	0.173	0.167	0.087	0.120	0.022	-0.106
2	-0.209	-0.299	-0.007	0.069	-0.055	-0.058	-0.046	0.024	0.060	0.045	0.043	0.088	-0.074	0.026	0.035	-0.241
4	-0.108	-0.334	-0.020	-0.028	0.079	-0.022	-0.035	0.017	0.055	0.040	0.068	0.118	0.005	0.050	-0.020	-0.122
6	0.380	-0.539	-0.053	-0.027	-0.040	0.024	-0.042	0.022	0.105	0.053	0.092	0.163	-0.006	0.029	-0.142	-0.113
8	1.057	-0.162	-0.018	0.039	-0.001	-0.010	0.070	0.057	0.078	0.045	0.141	0.181	0.127	-0.007	-0.138	-0.045
10	2.414	-0.306	-0.022	-0.001	-0.025	-0.017	-0.047	-0.008	0.022	0.033	0.114	0.118	0.031	0.043	-0.204	-0.003
12	3.853	0.182	-0.074	-0.040	-0.121	-0.103	-0.099	-0.067	-0.056	-0.041	0.078	0.081	0.023	-0.027	-0.145	0.047
14	3.813	1.652	-0.054	-0.029	-0.071	-0.101	-0.116	-0.090	-0.074	-0.121	0.060	0.117	-0.024	-0.062	-0.128	0.048
16	2.547	2.541	0.019	0.099	0.013	0.035	0.064	0.045	-0.003	0.014	-0.138	0.018	-0.025	-0.123	-0.238	-0.130
18	2.997	4.334	0.113	0.077	0.073	0.117	0.161	0.148	0.126	0.117	0.062	-0.023	-0.076	-0.121	-0.243	-0.113
20	-0.452	3.133	0.123	0.119	0.106	0.117	0.123	0.046	0.021	-0.061	-0.065	0.004	-0.044	-0.084	-0.174	-0.149
22	0.528	2.391	0.107	0.159	0.158	0.187	0.139	0.209	0.163	0.025	0.019	-0.106	-0.150	-0.018	-0.326	-0.127
24	1.669	3.555	0.167	0.319	0.247	0.308	0.263	0.294	0.244	0.193	0.098	-0.008	-0.023	-0.076	-0.082	-0.164
26	2.076	3.646	0.265	0.318	0.315	0.319	0.230	0.250	0.252	0.060	0.140	-0.014	0.015	0.023	-0.065	-0.213

TABLE #8: COMPARISON OF TABLE #1 WITH TABLE #3 *

STATION	STATION ELEVATION	STATION COORDINATES	* The values shown in Table 3 were subtracted from the values shown in Table 1	PREPARED BY	
Patrick AFB, Florida	7 meters MSL	28 deg 14 min N, 80 deg 36 min W		Army Ballistics Missile Agency Aeroballistics Laboratory Redstone Arsenal, Alabama 16 May 1960	PATRICK AFB, FLORIDA

Altitude (MSL) km	Zonal Mean m/s	Meridional Mean m/s / SD m/s	sfc	2	4	6	8	10	12	14	16	18	20	22	24	26
		Meridional Mean m/s	0.811	-1.628	-1.184	-0.538	0.171	0.729	1.603	2.113	1.360	0.610	0.161	0.106	0.130	0.262
		SD m/s	0.414	1.387	1.666	2.666	3.305	3.826	3.230	2.640	2.987	2.103	1.090	-0.025	1.199	1.435
sfc	0.994	-0.085	-0.116	0.058	0.086	0.109	0.123	0.161	0.147	0.168	0.161	0.088	0.082	-0.088	0.020	-0.121
2	3.011	0.341	-0.051	-0.093	0.003	0.013	0.029	0.046	0.051	0.039	0.051	0.073	0.061	-0.078	0.049	-0.054
4	5.822	-0.234	0.007	-0.023	0.032	0.021	0.040	0.058	0.072	0.065	0.073	0.105	0.128	0.091	-0.037	0.039
6	8.830	-0.889	0.023	-0.009	-0.062	0.077	0.010	0.031	0.069	0.054	0.077	0.167	0.117	0.063	-0.084	0.060
8	11.907	-1.272	0.039	0.032	-0.057	-0.074	0.107	0.026	0.022	0.028	0.079	0.135	0.135	-0.035	-0.114	0.122
10	15.144	-2.336	0.065	0.031	-0.083	-0.108	-0.097	0.158	-0.032	-0.010	0.035	0.101	0.118	0.081	-0.181	0.128
12	17.303	-3.698	0.034	-0.005	-0.170	0.215	-0.191	-0.185	0.128	-0.083	0.054	0.094	0.091	0.019	-0.088	0.048
14	17.613	-3.618	0.041	-0.001	-0.142	-0.221	-0.220	-0.196	-0.173	0.060	0.065	0.133	0.083	0.008	-0.097	0.062
16	15.527	-2.379	0.029	0.003	-0.186	-0.230	-0.209	-0.222	-0.196	-0.181	0.071	0.058	0.044	0.038	-0.141	-0.102
18	12.767	0.574	-0.150	-0.141	-0.262	-0.332	-0.288	-0.298	-0.279	-0.294	-0.255	0.103	0.008	0.088	-0.149	-0.058
20	8.628	0.933	-0.078	-0.181	-0.294	-0.392	-0.408	-0.436	-0.481	-0.486	-0.371	-0.343	0.173	0.009	-0.208	-0.023
22	9.018	1.371	-0.108	-0.204	-0.314	-0.393	-0.485	-0.408	-0.482	-0.561	-0.456	-0.521	-0.367	-0.076	-0.184	-0.161
24	11.269	-0.965	-0.144	-0.036	-0.220	-0.361	-0.396	-0.360	-0.466	-0.501	-0.470	-0.442	-0.348	-0.247	-.155	-0.084
26	13.656	-0.444	-0.053	-0.016	-0.200	-0.320	-0.390	-0.416	-0.450	-0.563	-0.497	-0.455	-0.347	-0.256	-0.177	0.029

TABLE #9: COMPARISON OF TABLE #4 WITH TABLE #5 *

STATION	STATION ELEVATION	STATION COORDINATES	* The values shown in Table 5 were subtracted from the values shown in Table 4		PREPARED BY	PATRICK AFB, FLORIDA
Patrick AFB, Florida	7 meters MSL	28 deg 14 min N, 80 deg 36 min W			Army Ballistics Missile Agency Aeroballistics Laboratory Redstone Arsenal, Alabama 16 May 1960	

Alt. (MSL) km / Alt. (MSL) km	sfc	2	4	6	8	10	12	14	16	18	20	22	24	26
sfc	2.83	- 0.05	- 0.59	- 0.76	0.96	3.86	3.39	- 4.30	-28.36	12.83	5.41	4.27	5.06	7.33
2		- 2.76	-13.70	-14.79	- 5.54	- 2.63	0.36	5.89	18.29	16.15	6.74	11.29	25.51	17.34
4			0.87	-18.74	-12.38	- 9.61	-12.62	4.37	19.64	24.57	12.97	15.47	23.69	26.31
6				-15.23	-16.82	- 8.57	11.64	6.11	33.40	41.23	17.48	22.62	28.97	34.79
8					20.58	- 0.12	4.63	13.72	60.12	65.80	32.01	19.40	31.40	36.47
10						- 0.43	5.96	26.53	66.05	71.98	22.31	41.10	40.31	50.34
12							38.65	66.09	70.42	78.22	21.43	32.24	36.70	58.72
14								99.82	94.91	86.43	12.23	7.52	29.72	22.01
16									93.06	71.41	25.17	13.85	15.48	24.47
18										116.67	36.73	4.58	15.75	19.80
20											72.14	13.91	24.28	45.19
22												49.24	20.28	29.31
24													79.67	47.18
26														61.75
Alt. (MSL) km	sfc	2	4	6	8	10	12	14	16	18	20	22	24	26

TABLE #10: COMPARISON OF TABLE #4 WITH TABLE #6 *

STATION	STATION ELEVATION	STATION COORDINATES	*The values shown in Table 6 were subtracted from the values shown in Table 4		PREPARED BY	
Patrick AFB, Florida	7 meters MSL	28 deg 14 min N, 80 deg 36 min W			Army Ballistics Missile Agency Aeroballistics Laboratory Redstone Arsenal, Alabama 16 May 1960	PATRICK AFB, FLORIDA

Alt. (MSL) km \ Alt. (MSL) km	sfc	2	4	6	8	10	12	14	16	18	20	22	24	26
sfc	- 0.70	4.43	8.06	6.58	8.49	11.99	8.24	- 1.20	- 0.83	- 0.12	- 1.29	- 2.66	- 8.87	- 8.16
2		14.67	13.38	14.04	33.39	15.85	5.38	1.67	4.62	- 2.70	- 8.70	- 11.39	1.08	- 1.86
4			25.79	33.21	12.46	1.86	- 21.81	- 22.84	- 13.32	- 13.56	- 17.31	- 23.03	- 20.48	21.04
6				50.54	12.88	4.87	- 19.41	-100.70	- 30.31	- 23.70	- 35.83	- 40.88	- 47.47	- 47.62
8					81.24	37.23	- 80.49	- 63.93	- 34.62	- 28.68	- 46.55	- 69.90	- 70.47	- 70.07
10						105.90	- 77.24	- 92.63	- 63.58	- 44.48	- 68.24	- 68.44	- 86.83	- 97.52
12							30.12	-119.93	- 77.38	- 56.48	- 87.93	- 95.38	-117.84	-133.01
14								- 39.19	- 75.65	- 57.33	- 94.30	-112.67	-121.06	-152.04
16									13.70	- 35.59	- 53.92	- 69.89	- 91.24	-117.22
18										65.36	- 28.54	- 56.30	- 59.16	- 75.37
20											47.92	- 23.66	- 31.89	- 38.33
22												34.81	- 19.04	- 34.02
24													51.44	- 18.16
26														5.92
Alt. (MSL) km	sfc	2	4	6	8	10	12	14	16	18	20	22	24	26

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